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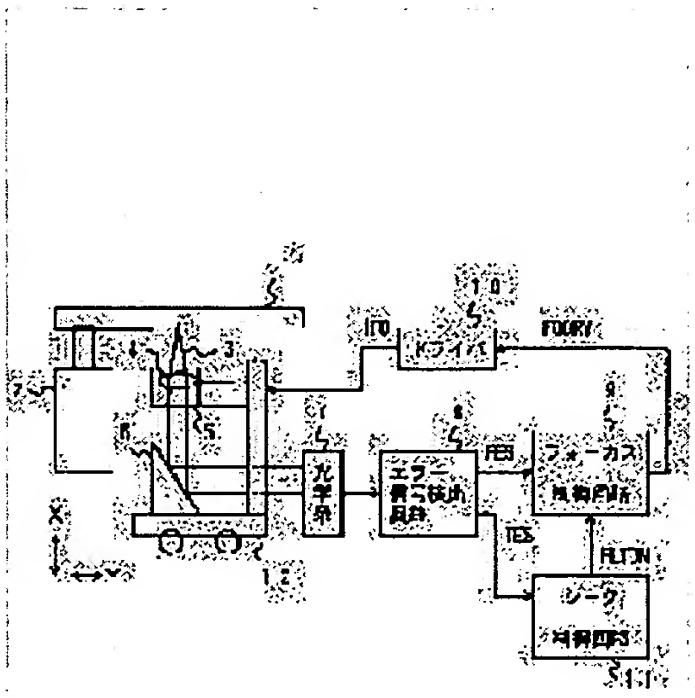
(54) FOCUS CONTROL DEVICE OF OPTICAL DISK APPARATUS

(57)Abstract:

PROBLEM TO BE SOLVED: To provide a focus control device of optical disk apparatus which assures stable focus control operation even during the seek operation while controlling the focus control by a sampling control method.

SOLUTION: In the optical disk apparatus for controlling the focusing condition of a laser beam by feeding back a focus error signal indicating defocusing amount of laser beam for an optical disk, the focus control device which comprises an error signal detecting circuit 8 which samples the focus error signal for every sampling period (T) in the feedback loop and a notch fileter 22 having the minimal point of the gain at the frequency 1/(2T) to attenuate the crosstalk element superimposed to the focus error signal even if resolution of the drive signal is insufficient is provided.



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CLAIMS

[Claim(s)]
[Claim 1] In case a laser beam is irradiated in the code track on an optical disk and informational record and/or playback are performed The focal error signal which shows the amount of focal gaps to said optical disk of said laser beam is detected. In the focal control unit of the optical disk unit which forms the loop formation which returns said focal error signal to the focal actuator which drives the focal location of said laser beam, and controls punctate [of said laser beam] the sampling period which set up said focal error signal beforehand into said loop formation -- (-- with a sampling means to sample to every T) 1/(2T) of frequencies Focal control unit of the optical disk unit characterized by providing a notch filter means with the minimum point of gain.
[Claim 2] The focal control unit of said optical disk unit Furthermore, a selection means to choose and output either the output of said sampling means, or the output of said notch filter means, A phase compensation means to perform phase compensation in order to consider the output of said selection means as an input and to stabilize focal control, The focal control unit of the optical disk unit according to claim 1 characterized by having a driver means to drive said focal actuator, and being constituted based on the output of said phase compensation means.
[Claim 3] Irradiate a laser beam in the code track on an optical disk, and informational record and/or playback are performed. The focal error signal which shows the amount of focal gaps to said optical disk of said laser beam is detected. In the focal control unit of the optical disk unit which forms the loop formation which returns said focal error signal to the focal actuator which drives the focal location of said laser beam, and controls punctate [of said laser beam] Into said loop formation, a DIP frequency adjustable notch filter with the DIP frequency strange good from which gain serves as the minimum is prepared. The inside of the seek operation which operates so that said laser beam may cross the code track formed on said optical disk, The focal control unit of the optical disk unit characterized by the thing by which abbreviation etc. spreads said code track on the frequency in which said laser beam crosses said DIP frequency, and which is changed so that it may become.

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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Field of the Invention] This invention relates to the focal control unit which is applied to the optical disk unit which irradiates a laser beam in the code track on an optical disk, and performs informational record and playback, especially controls punctate [of a laser beam].
[0002]
[Description of the Prior Art] Generally, in the optical disk unit which uses a magneto-optic disk etc. for a record medium, in order for a laser beam to perform informational record and playback, various control is performed. For example, in order to access the focal control controlled so that a laser beam connects a focus on an optical disk, the tracking control controlled so that a laser beam follows the code track on a disk, and the distant code track, control of the seeking control which carries out drive control of the laser beam so that a code track may be crossed is performed, respectively.
[0003] Among these, focal control detects the condition of a focal gap as a focal error signal with a certain method, and is performed by driving an objective lens to the travelling direction of a laser beam based on a focal error signal. At this time, the signal through the phase lag compensation for raising the flattery nature of the phase lead compensation for stabilizing not the focal error signal itself but focal control action and focal control is impressed to the focal actuator which drives an objective lens. Of course, it is necessary to always operate focal control to normal regardless of under tracking system Messrs. and seeking control.
[0004] By the way, if the laser beam crosses the code track at the time of seek operation, it is known that the alternating current component (cross talk) which synchronized with truck crossing is overlapped on a focal error signal.
[0005] And when a cross talk component is overlapped on a focal error signal, there is a problem of the drive signal (output of phase compensation) of a focal actuator being in the condition of having vibrated and having been saturated with the frequency of a cross talk (clip), and it becoming impossible to perform normal focal control as pointed out by JP,7-169070,A.

[0006] In recent years, the sampling control (digital control) by DSP (Digital SignalProcessor) is used abundantly for low-cost-izing of equipment, the improvement in dependability, etc. It becomes impossible however, to perform normal focal control still more notably in this sampling control.
[0007] That is, although it will be controlled by duty ratio of a drive signal by the focal location where a drive signal is vibrated and saturated, in sampling control, the resolution of duty ratio will be decided by the period of a sampling. for this reason, resolving power -- the error of the drive signal itself becomes large and it is easy to produce a focal big gap on the frequency to which the most disadvantageous drive signal vibrates to positive/negative for every sampling period-like, i.e., the frequency from which a cross talk frequency is set to one half of sampling frequencies.
[0008] And although the tracking error signal is performing count of the number of crossing trucks, and detection of passing speed as for the inside of seek operation, since the amplitude of a tracking error signal will fall if a focal gap occurs, these actuation becomes impossible and it may fail in seek operation.
[0009] Moreover, in JP,5-135381,A, in order to prevent the focal gap by the cross talk component mentioned above, bias voltage is applied to a focal error signal, the control point of a focus is moved from a true focusing point for a while, and the technique of reducing the amount of cross talks is indicated. Since the amount of cross talks changes with focal conditions, this is [the amount] effective in preventing malfunction of focal control.
[0010] Furthermore, the technique of adding applying the suitable gain for the sum signal which shows the reinforcement of the tracking error signal and the reflected light which express a tracking error with JP,7-169070,A, generating a cross talk assistant Masanobu number, adding to a focal error signal, and canceling a cross talk component is indicated.
[0011]
[Problem(s) to be Solved by the Invention] However, although the focal gap by adding bias to a focal error signal occurs with the technique indicated by JP,5-135381,A mentioned above and a cross talk decreases by this, since the amplitude of a tracking error signal also falls, it is difficult to prevent a truck count and malfunction of speed detection.
[0012] Moreover, with the technique indicated by JP,7-169070,A, there is a problem that it is difficult to generate a cross talk assistant Masanobu number with a sufficient precision, and a circuit complicated for generation of an amendment signal is needed.

[0013] Also in which technique furthermore mentioned above, when sampling control is performed, especially about the phenomenon of becoming unstable, it is not taken into consideration at all in the neighborhood a cross talk frequency becomes one half of sampling frequencies, but there is possibility that focal control will become unstable, by the cross talk component which it was not able to finish removing by amendment.
[0014] Then, this invention aims at offering the focal control unit of the optical disk unit in which the focal control stabilized in seek operation is possible, without being influenced of a cross talk, controlling focal control by sampling control.
[0015]
[Means for Solving the Problem] In order to attain the above-mentioned purpose, this invention irradiates a laser beam in the code track on an optical disk, and performs informational record and/or playback. The focal error signal which shows the amount of focal gaps to said optical disk of said laser beam is detected. In the focal control unit of the optical disk unit which forms the loop formation which returns said focal error signal to the focal actuator which drives the focal location of said laser beam, and controls punctate [of said laser beam] the inside of said loop formation -- said focal error signal -- a sampling period -- (-- the focal control unit of the optical disk unit which has a sampling means to sample to every T), and the notch filter means which has the minimum point of gain in 1/(2T) of frequencies is offered.
[0016] By the above configurations, the frequency of a cross talk component is set to one half of sampling frequencies, the cross talk component superimposed on the focal error signal by work of the filter which has the gain minimum point in 1/(2T) (1/2 of a sampling frequency) of frequencies even if it was a case so that the resolution of a drive signal may run short, declines effectively, and the focal control action stabilized without being influenced of a cross talk becomes possible.
[0017]
[Embodiment of the Invention] Hereafter, the operation gestalt of this invention is explained to a detail with reference to a drawing. Drawing 1 is drawing showing the configuration of the optical disk unit containing the focal control device as 1st operation gestalt by this invention. Here, drawing 1 shows only the configuration used as the summary of this invention characteristic.
[0018] The spindle motor 2 for this optical disk unit laying the optical disk 1 which records information, and this optical disk 1, and making it rotate them at a predetermined rotational frequency, The laser beam 3 which the recording surface of an optical disk 1 irradiates and performs informational record and playback, The objective lens 4 for condensing a laser beam 3, and the focal actuator 5 for driving this objective lens 4 in the direction of an optical axis (X shaft orientations), and moving the focal location to the optical disk 1 of a laser beam 3, The optical system 7 constituted including the photodetector for detecting the reflective mirror 6 and the reflected light from semiconductor laser or an optical disk 1 used as the light source, The error signal detector 8 for detecting the error signals (a focal error signal, tracking error signal, etc.) of a servo, The focal control circuit 9 which performs phase compensation of a focus servo system etc., and the driver 10 for carrying out the current drive of said focal actuator 5, The seeking control circuit 11 mentioned later, and said focal actuator 5 and reflective mirror 6 are carried, and it consists of movable carriage 12 in the direction (Y shaft orientations) which crosses a code track. The focal control circuit 9 shall be realized by DSP (Digital Signal Processor) in this operation gestalt.
[0019] The detailed configuration of said focal control circuit 9 shown in drawing 1 is shown in drawing 2 . A/D converter 21 for said focal control circuit 9 to carry out A/D conversion of the focal error signal (FES) detected by the error signal detector 8 mentioned above a period T (sampling frequency 1/T), The filter 22 which has the minimum point of gain in one half of the frequencies of a sampling frequency (1/T) (notch filter), The selector 23 which chooses and outputs one of the output of said A/D converter 21, and the outputs of a filter 22, It consists of D/A converters 25 at least for that for stabilizing a focus servo system to carry out D/A conversion of the output of the phase compensating filter 24 and the phase compensation time filter 24.
[0020] Moreover, as for the phase compensating filter 24, at least the above consists of a phase lag compensating filter 26, a phase-lead-compensation filter 27, and an adder 28. Here, A/D and the D/A converter inside the focal control circuit 9, and filters operate altogether synchronizing with a sampling clock. A sampling frequency is set up with 30kHz (33.3 microseconds of sampling periods), and this operation gestalt explains it.
[0021] The detailed configuration of the seeking control circuit 11 shown in drawing 1 is shown in drawing 3 . However, this seeking control circuit may be constituted as an electrical circuit, and that part or whole may be realized by processing by DSP.
[0022] The binary-ized circuit 31 where this seeking control circuit 11 performs binary-ization of a tracking error signal (TES), The truck count circuit 32 which detects the number of migration trucks at the time of seeking by counting a binary-ized signal, The target rate arithmetic circuit 33 which is made to correspond to truck counted value and finds the seeking target rate in the time, The judgment circuit 34 which determines the value of a control signal FLTON with the value of a target rate, binary ---izing -- a signal -- a period -- from -- current -- passing speed -- asking -- a rate -- a detector -- 35 -- a target -- a rate -- current -- passing speed -- from -- not illustrating -- tracking -- (-- Tr --) -- an actuator -- a driving signal -- asking -- a speed control circuit -- 36 -- constituting -- having .
[0023] Thus, in the constituted optical disk unit, it is reflected by the reflective mirror 6 and the laser beam 3 which carried out outgoing radiation from the laser diode contained in the optical system 7 shown in drawing 1 is condensed by the front face of an optical disk 1 with an objective lens 3. The laser beam reflected with said optical disk 1 is again reflected by the reflective mirror 6 through an objective lens 3, and the quantity of light of the reflected light is detected by the photodetector contained in optical system 7 at return and optical system 7.
[0024] At this time, the focal condition over the optical disk 1 of a laser beam 3 is detected as change of the quantity of light

by the optical system for the focal error detection within optical system 7, and is detected as a focal error signal (FES) by the operation in the error signal detector 8. Although there are various approaches in the method of detecting a focal error here, it is easy to be general and explanation is omitted here.
[0025] In said error signal detector 8, the tracking error signal (signal in which the location which the laser beam 3 is irradiating from the center of a code track means which has shifted) TES is also doubled and detected.
[0026] And the focal control circuit 9 carries out negative feedback of the focal error signal to a focal actuator so that the detected focal error signal may become zero, namely, so that a focus may suit a disk front face. In order to perform phase lead compensation at this time in order to stabilize negative feedback actuation, and to raise flattery nature of operation, it is common to carry out by doubling phase lag compensation. Usually, it only outputs during tracking etc. that a selector 23 chooses the output of A/D converter 21 to the phase compensating filter 24.
[0027] On the other hand, at the time of seek operation, a selector 23 chooses the output in the direction of a filter 22 with the control signal FLTON from the seeking control circuit 11. Here, the frequency characteristics of a filter 22 have the minimum point of gain in the frequency of 1/2 of 30kHz which is a sampling frequency, and 15kHz.
[0028] In the case of an analog circuit, such a property is generated with a twin T filter, but in the case of a digital filter, even if it is the filter of a simple high region cutoff filter (LPF) property, the minimum point of gain appears in one half of the frequencies of a sampling frequency by digitization (bilinear transform), and the same property is acquired. For example G(s) =1/(1.06x10-5-s+1) .... (1)
LPF of 15kHz of cut off frequencies come out of and expressed is a transfer function if the bilinear transform of this is carried out with the sampling frequency of 30kHz, although it has frequency characteristics as shown in drawing 4 . G (z) =0.611(z+1)/(z+0.222) -- (2)
It becomes the frequency characteristics which have the minimum point of gain in 15kHz as shown in a next door and drawing 5 . The filter 22 of this operation gestalt shall be a digital filter with these frequency characteristics.
[0029] When the laser beam 3 moves in the direction which crosses the code track on an optical disk like [at the time of seek operation], the cross talk component which synchronized with the truck cross is overlapped on a focal error signal. If it seeks, choosing the output of an A/D converter by the selector 23 (equivalent to the conventional method), near the frequency a cross talk frequency becomes one half of sampling frequencies as shown in drawing 6 , a focus servo will become unstable and a focal gap will arise (a maximum of about 0.8 micrometers).
[0030] As the term of the conventional technique described this, it is because the resolving power of the drive signal which the frequency of a cross talk approaches one half of sampling frequencies, and the resolving power of time amount shaft orientations is insufficient, and returns to a focal actuator falls.
[0031] So, in this invention, to the seeking target rate in the time of being outputted from the target rate arithmetic circuit 33, it judges whether it is a speed range predetermined in the judgment circuit 34, a FLTON signal is outputted, the output of a filter 22 is chosen by the selector 23, and the signal inputted into the phase compensating filter 24 is changed to the output of a filter 22 (suppose that it changes to the output of a filter 22 by 0.05 or less m/s).
[0032] Then, as shown in drawing 7 , in order that a cross talk component may decline near the frequency at which a focus servo is the easiest to be shaken, a focus servo stops being influenced of a cross talk easily, and focal ****** becomes very small (a maximum of about 0.4 micrometers). Furthermore, the vibration of the drive signal FODRV has decreased and reduction of power consumption also becomes possible.
[0033] The timing which changes this selector 23 to the output of a filter 22 should just center on the rate from which a cross talk component is set to one half of sampling frequencies. For example, if a track pitch sets to 1.4 micrometers and a sampling frequency sets to 30kHz, the passing speed from which a cross talk component becomes 1/2 of a sampling frequency, i.e., 15kHz, will be set to 15(kHz) x1.4(micrometer) =0.021 (m/s).
[0034] Usually, if the filter of a property like a filter 22 is inserted into a servo loop, a servo will become unstable by the phase lag in many cases. For this reason, although the short thing of the time amount which chooses the output of a filter 22 by the selector 23 is desirable, since focal ****** by the cross talk starts early rather than a cross talk is set to 15kHz so that drawing 6 may show, it is desirable to see some allowances focusing on the frequency used as 15kHz, and to set up speed range.
[0035] Next, the detailed example of a configuration of the focal control circuit of the 2nd operation gestalt is shown in drawing 8 , and it explains to it. Here, in this focal control circuit, the same reference mark is given to the same configuration part as the configuration part shown in drawing 2 , and that explanation is omitted to it.
[0036] Although the primary digital filter of the property expressed with (2) types was constituted from a rate field which is easy to be influenced of a cross talk and at least the output was inputted into the phase compensating filter 24 as a filter 22 with the 1st operation gestalt mentioned above, a filter 22 does not necessarily need to be such a digital filter.
[0037] Focal control circuit 9a shown in drawing 8 replaces a filter 22 in a delay element (memory) 81 and the average-value calculation circuit 82, and acquires the same effectiveness for a digital filter by un-using it. Although these delay elements 81 and the averaging circuit 82 can also be built as an electrical circuit, it is desirable for DSP to realize by software together with a phase compensating filter.
[0038] The configuration of this focal control circuit 9a will be G(z) = (1+Z-1)/2, if the transmission characteristic from a focal error signal to the output of the averaging circuit 82 is expressed with a formula, although it is exactly calculating the average of the newest A/D-conversion result of a focal error signal, and the last A/D-conversion result (before 1 sample). .... (3)

A next door and frequency characteristics become what had the minimum point of gain in 15kHz which is 1/2 of a sampling frequency, as shown in drawing 9 . For this reason, if focal control circuit 9a shown in drawing 8 is used instead of the focal control circuit 9 shown in drawing 2 , a digital filter becomes unnecessary and can acquire the same effectiveness by data processing in very easy DSP.
[0039] In addition, this is under seeking, although it was under seeking and at least the predetermined rate (0.05 or less m/s) changed the input signal to the phase compensating filter 24 to the filter 22 or the averaging circuit 82 with this operation gestalt, It is good as for always changed.
[0040] However, since a filter and the phase lag by processing of equalization occur and the phase margin decreases as shown in drawing 5 or drawing 9 , it is desirable to change to especially a cross talk by limiting to a weak speed range.
[0041] Moreover, although both phase lead compensation and phase lag compensation were used as a phase compensating filter with this operation gestalt, this may be only phase lead compensation, or processes phase lag compensation independently, and you may make it input the signal through the filter which has the gain minimum point only in phase lead compensation one half of sampling frequencies.
[0042] Furthermore, the frequency and DIP frequency from which gain serves as the minimum are good also as adjustable. When it constitutes the notch filter which has a DIP in one half of sampling frequencies by calculating an average value with a value last time, it is difficult but to change a DIP frequency in order to change a sampling frequency, and when it constitutes as a digital filter, it is possible to change a DIP frequency to some extent.
[0043] Then, it becomes possible to make it correspond to the frequency of the cross talk component superimposed on the focal error signal, to change a DIP frequency, and to carry out a focus servo to stability in ** and the cross talk of a larger frequency range, i.e., a larger seeking speed range. In this case, what is necessary is to calculate a DIP frequency to rate desired value by the DIP frequency arithmetic circuit 101, and just to make it the configuration which changes the DIP frequency of filter 22a, as shown in drawing 10 . Here, the DIP frequency f can except the effect of a cross talk effectively, without asking for f=v/p, then the frequency component of a cross talk directly from the track pitch p of the code track on the rate desired value v and an optical disk. In addition, the track pitch in this case is the distance of the center of a land which adjoins from the center of a land on a disk, or groove centers, and is the distance corresponding to a round term of a cross talk.
[0044] Of course, a DIP frequency may be changed not according to rate desired value but according to a speed detection value. Moreover, a selector may be changed on the basis of a speed detection value also with the 1st and 2nd operation gestalt.
[0045] Although the above operation gestalt was explained, the following invention is also included in this specification.
(1) Irradiate a laser beam in the code track on an optical disk, and perform informational record and/or playback. The focal error signal which shows the amount of focal gaps to said optical disk of said laser beam is detected. In the focal control unit of the optical disk unit which forms the loop formation which returns said focal error signal to the focal actuator which drives the focal location of said laser beam, and controls punctate [of said laser beam] the inside of said loop formation -- said focal error signal -- a sampling period -- (-- the focal control unit of an optical disk unit characterized by establishing a sampling means-to-sample to every T), and the notch filter means which has the minimum point of gain in 1/(2T) of frequencies.
[0046] Since this prepared the notch filter which has the gain minimum point in 1/(2T) of frequencies, when sampling control performs a focus servo, a cross talk component can be effectively decreased on the frequency which is the easiest to be influenced of a cross talk, and the stable focus servo actuation is attained.
[0047] (2) said -- a sampling -- a means -- an output -- or -- said -- a notch filter -- a means -- an output -- either -- choosing -- outputting -- selection -- a means -- said -- selection -- a means -- an output -- an input -- ** -- carrying out -- a focus -- control -- stabilizing -- a sake -- phase compensation -- carrying out -- phase compensation -- a means -- said -- phase compensation -- a means -- an output -- being based -- said -- a focus -- an actuator -- driving -- a driver -- a means -- containing -- constituting -- having -- things -- the description -- ** -- carrying out -- the above -- (-- one --) -- a term -- a publication -- an optical disk unit -- a focus -- a control unit .
[0048] Since it can choose by this whether a notch filter is constructed in a servo loop with a selection means, when a focus servo becomes unstable by the phase lag of a notch filter, a notch filter can be separated, and it becomes possible to carry out the usual focus servo actuation to stability.
[0049] (3) said -- a notch filter -- a means -- said -- a focus -- an error signal -- the newest -- a sampling -- a value -- last time -- a sampling -- a value -- the average -- asking -- outputting -- a thing -- it is -- things -- the description -- ** -- carrying out -- the above -- (-- one --) -- a term -- or -- (-- two --) -- a term -- a publication -- an optical disk unit -- a focus -- a control unit .

[0050] In order for this to acquire the same frequency characteristics as a notch filter and to use equalization, it becomes possible to simplify the contents of processing in the case of processing especially by DSP.
(4) said -- selection -- a means -- said -- a laser beam -- said -- an optical disk -- a top -- preparing -- having had -- a code track -- crossing -- as -- operating -- seek operation -- inside -- said -- a filter -- a means -- an output -- choosing -- being other -- a condition -- **** -- said -- a sampling -- a means -- an output -- choosing -- things -- the description -- ** -- carrying out -- the above -- (-- two --) -- a term -- or -- (-- three --) -- a term -- a publication -- an optical disk unit -- a focus -- a control unit .
[0051] Thereby, in order to incorporate a notch filter into a servo loop only during seeking, it becomes possible to prevent

focus servo actuation becoming unstable by the phase lag of a notch filter during tracking actuation.
[0052] (5) said -- selection -- a means -- said -- seek operation -- inside -- said -- seeking -- a rate -- predetermined -- speed range -- having become -- things -- said -- a filter -- a means -- an output -- choosing -- being other -- a condition -- **** -- said -- a sampling -- a means -- an output -- choosing -- things -- the description -- ** -- carrying out -- the above -- (-- four --) -- a term -- a publication -- an optical disk unit -- a focus -- a control unit .
[0053] Thereby, in order to incorporate a notch filter into a servo loop only in a predetermined speed range in seek operation, it becomes possible to prevent focus servo actuation becoming unstable by the phase lag of a notch filter in the period of most in tracking actuation and seek operation.
[0054] (6) said -- selection -- a means -- at least -- said -- seeking -- a rate -- said -- a sampling period -- T -- and -- said -- a code track -- a track pitch -- p -- receiving -- p -- / (2T) -- becoming -- a rate -- setting -- said -- a filter -- a means -- an output -- choosing -- a thing -- it is -- things -- the description -- ** -- carrying out -- the above -- (-- five --) -- a term -- a publication -- an optical disk unit -- a focus -- a control unit .
[0055] In order for this to incorporate a notch filter into a servo loop in the cross talk frequency and rate at which a focus servo is the easiest to be shaken, it becomes possible to stabilize a focus servo efficiently.
[0056] (7) Irradiate a laser beam in the code track on an optical disk, and perform informational record and/or playback. The focal error signal which shows the amount of focal gaps to said optical disk of said laser beam is detected. In the focal control unit of the optical disk unit which forms the loop formation which returns said focal error signal to the focal actuator which drives the focal location of said laser beam, and controls punctate [of said laser beam] Into said loop formation, a DIP frequency adjustable notch filter with the DIP frequency strange good from which gain serves as the minimum is prepared. The inside of the seek operation which operates so that said laser beam may cross the code track formed on said optical disk, The focal control unit of the optical disk unit characterized by the thing by which abbreviation etc. spreads said code track on the frequency in which said laser beam crosses said DIP frequency, and which is changed so that it may become.
[0057] Thereby, by changing the DIP frequency of a notch filter, it can respond to the cross talk of a larger frequency range, and it becomes possible to stabilize focus servo actuation at all seeking rates.
[0058]
[Effect of the Invention] Since the filter which has the minimum point of gain in the frequency which becomes 1/(2T) to a sampling period (T) was prepared into the focal control loop according to this invention as explained in full detail above, Even if it is in the condition that the frequency of a cross talk is set to one half of sampling frequencies, and the focal control by sampling control tends to become unstable The focal control unit of the optical disk unit which becomes possible [performing stable focus servo actuation, without being influenced of a cross talk component] can be offered.

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DESCRIPTION OF DRAWINGS

[Brief Description of the Drawings]
[Drawing 1] It is drawing showing the configuration of the optical disk unit containing the focal control device as 1st operation gestalt.
[Drawing 2] It is drawing showing the detailed configuration of the focal control circuit shown in drawing 1 .
[Drawing 3] It is drawing showing the detailed configuration of the seeking control circuit shown in drawing 1 .
[Drawing 4] It is drawing showing the frequency characteristics of the output of LPF, and a phase and gain.
[Drawing 5] It is drawing showing a phase and frequency characteristics with gain with the output of the digital filter of the 1st operation gestalt.
[Drawing 6] It is drawing for explaining the focal gap by the Prior art.
[Drawing 7] It is drawing for explaining the focal gap in the 1st operation gestalt.
[Drawing 8] It is drawing showing the detailed example of a configuration of the focal control circuit of the 2nd operation gestalt.
[Drawing 9] It is an output in the 2nd operation gestalt, and is drawing showing a phase and frequency characteristics with gain.
[Drawing 10] It is drawing showing the modification of the 2nd operation gestalt.
[Description of Notations]
1 -- Optical disk
2 -- Spindle motor
3 -- Laser beam
4 -- Objective lens
5 -- Focal actuator
6 -- Reflective mirror
7 -- Optical system
8 -- Error signal detector
9 -- Focal control circuit
10 -- Driver
11 -- Seeking control circuit
12 -- Carriage
21 -- A/D converter
22 -- Filter (notch filter)
23 -- Selector
24 -- Phase compensation time filter
25 -- D/A converter
26 -- Phase lag compensating filter
27 -- Phase-lead-compensation filter
28 -- Adder

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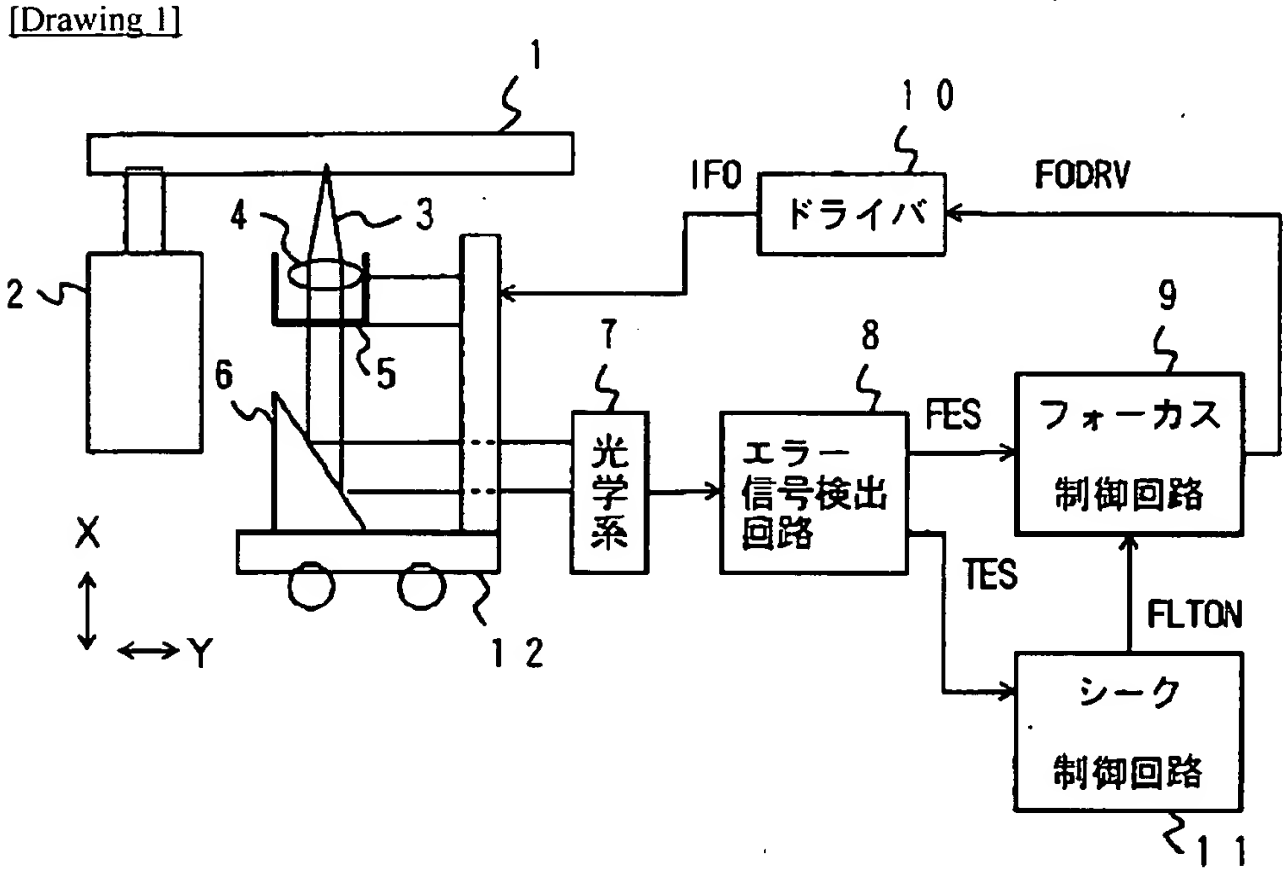
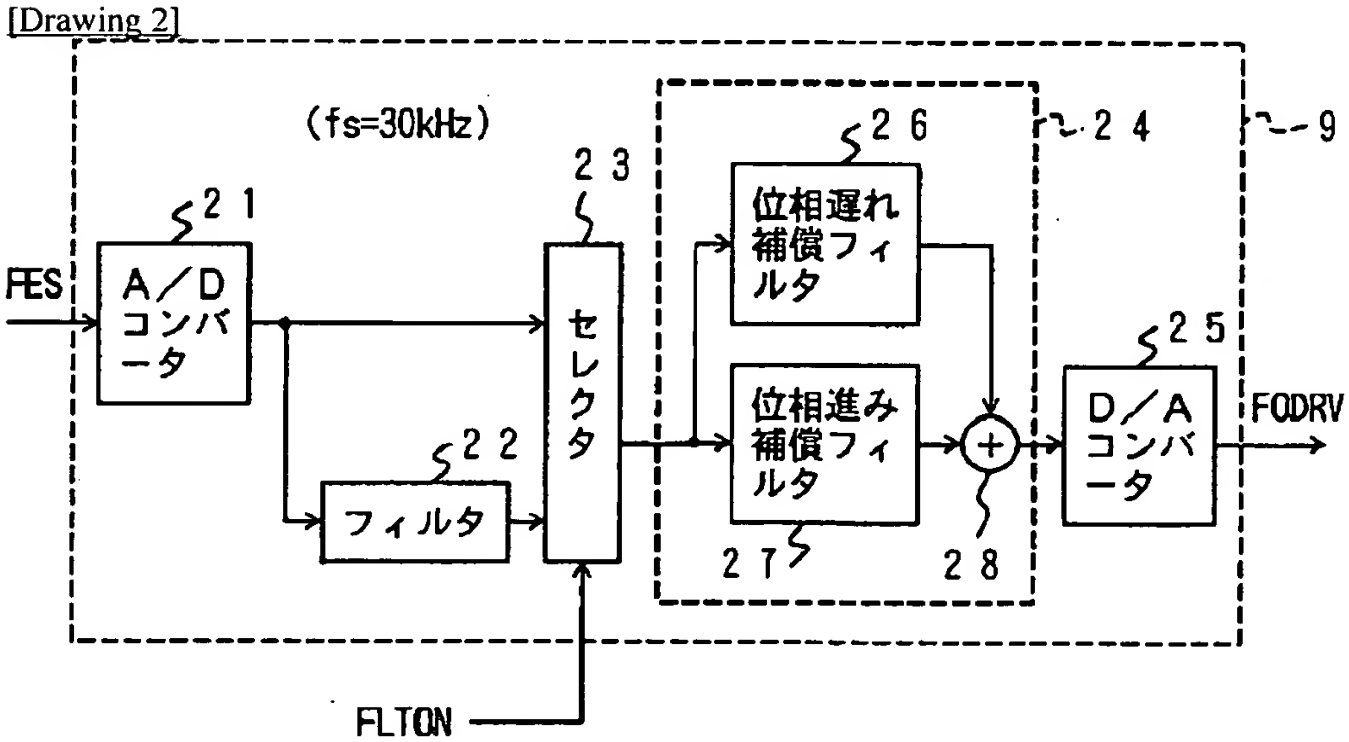
DRAWINGS

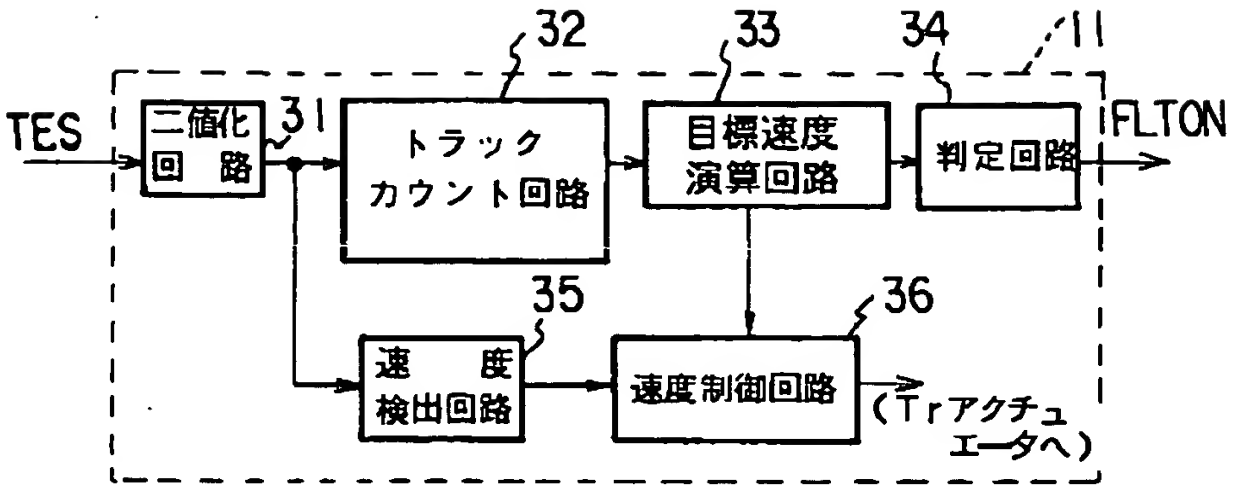
[Drawing 1]



[Drawing 2]



[Drawing 3]



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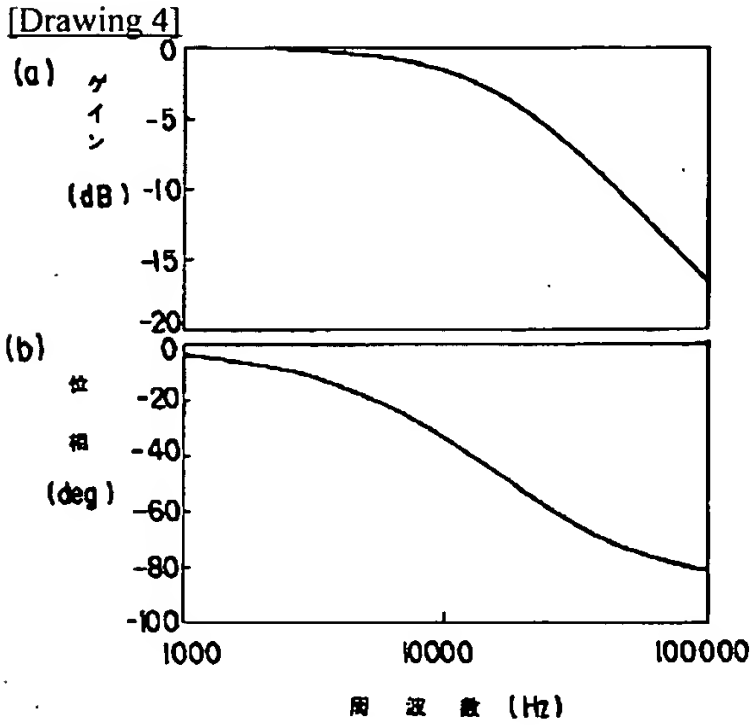
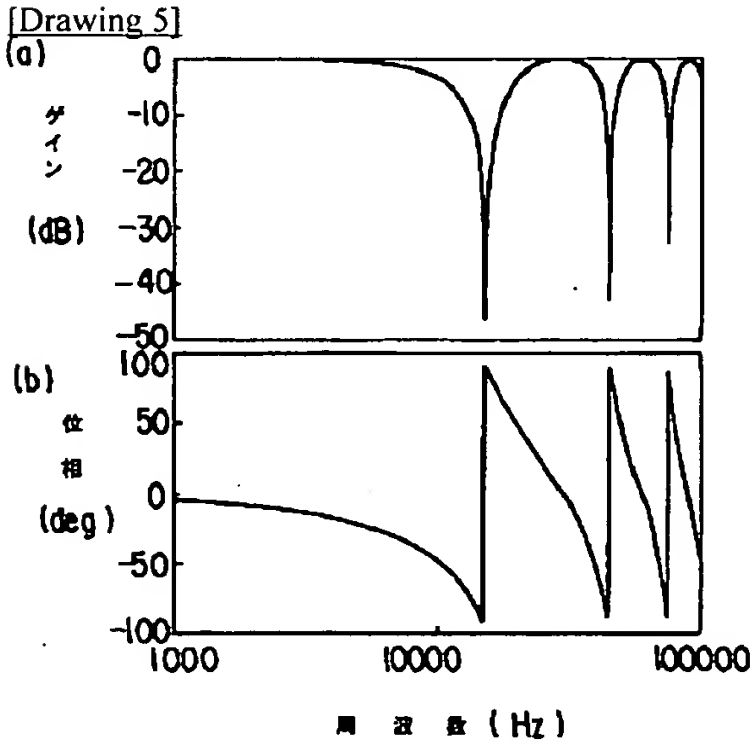
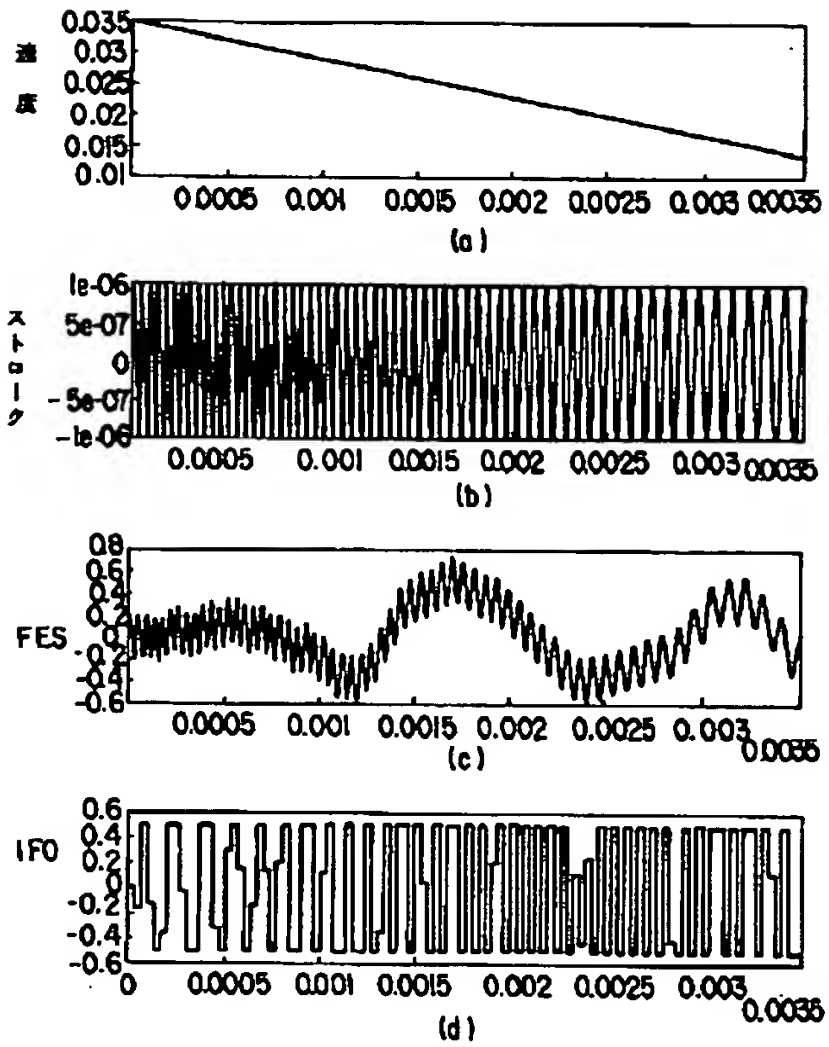


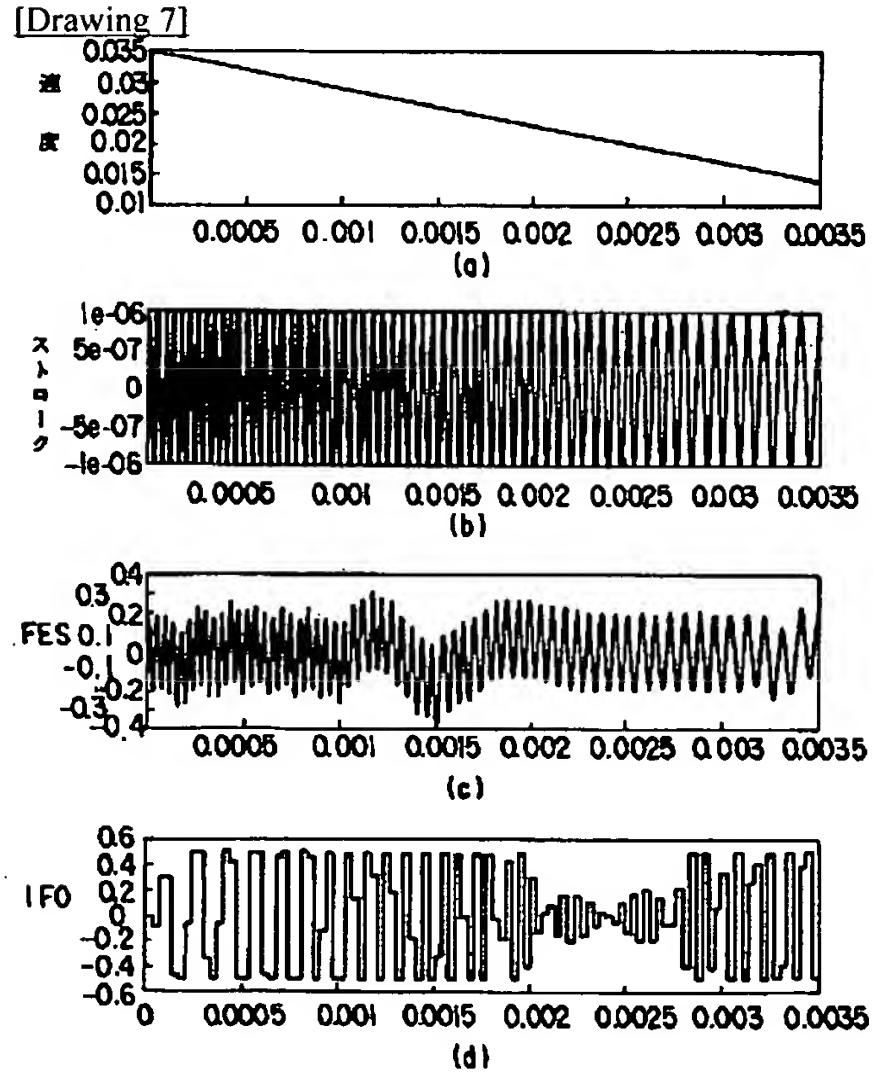
[Drawing 5]



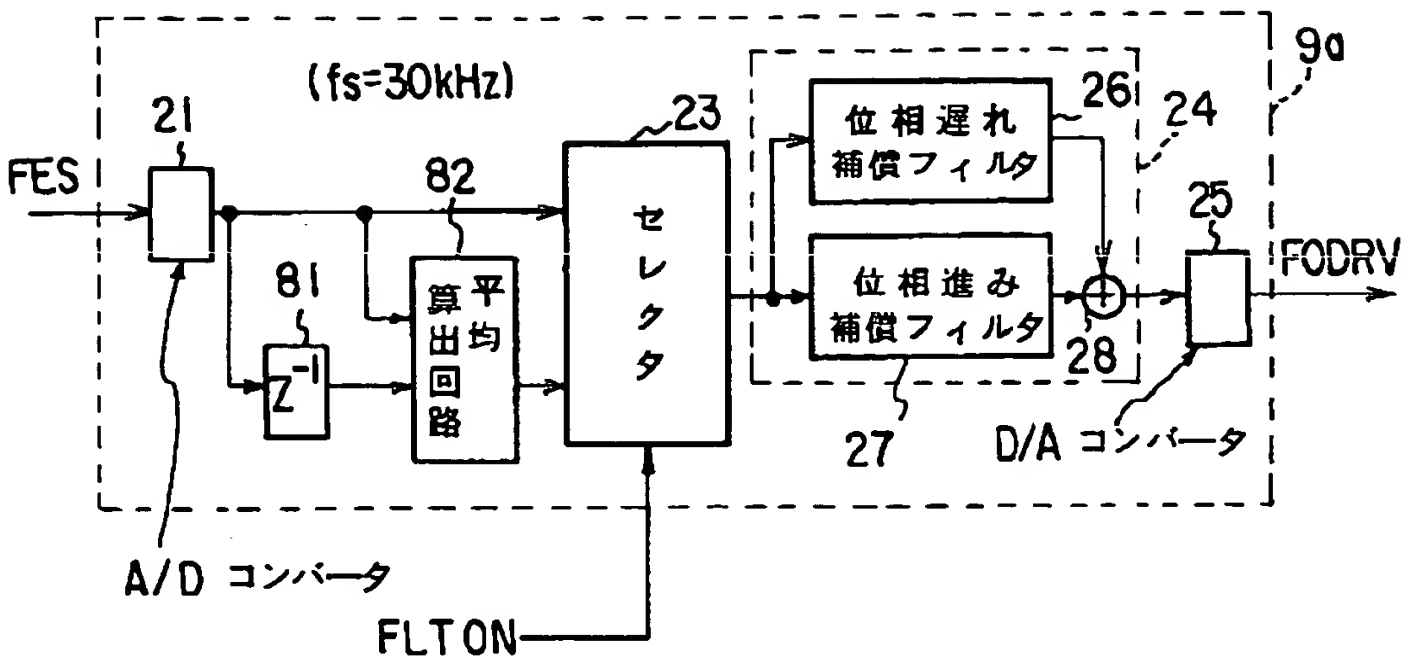
[Drawing 6]



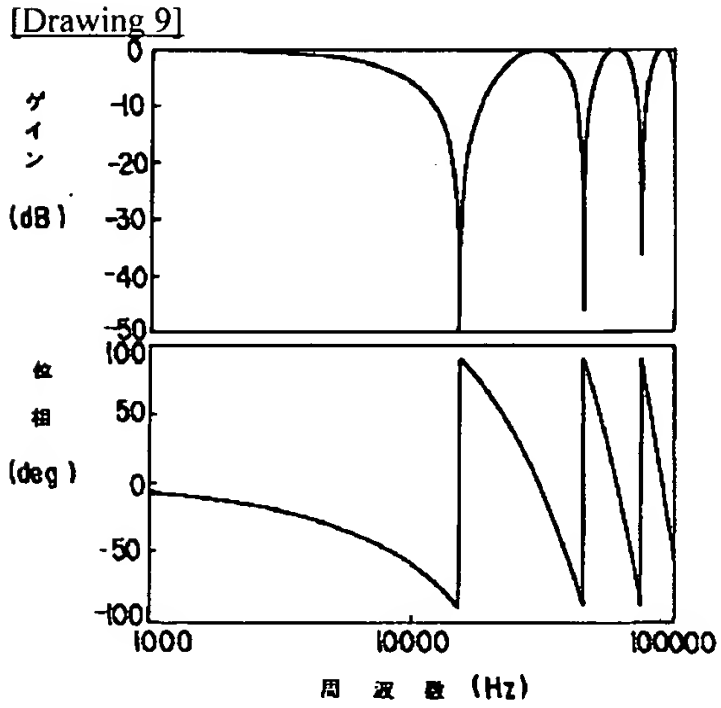
[Drawing 7]



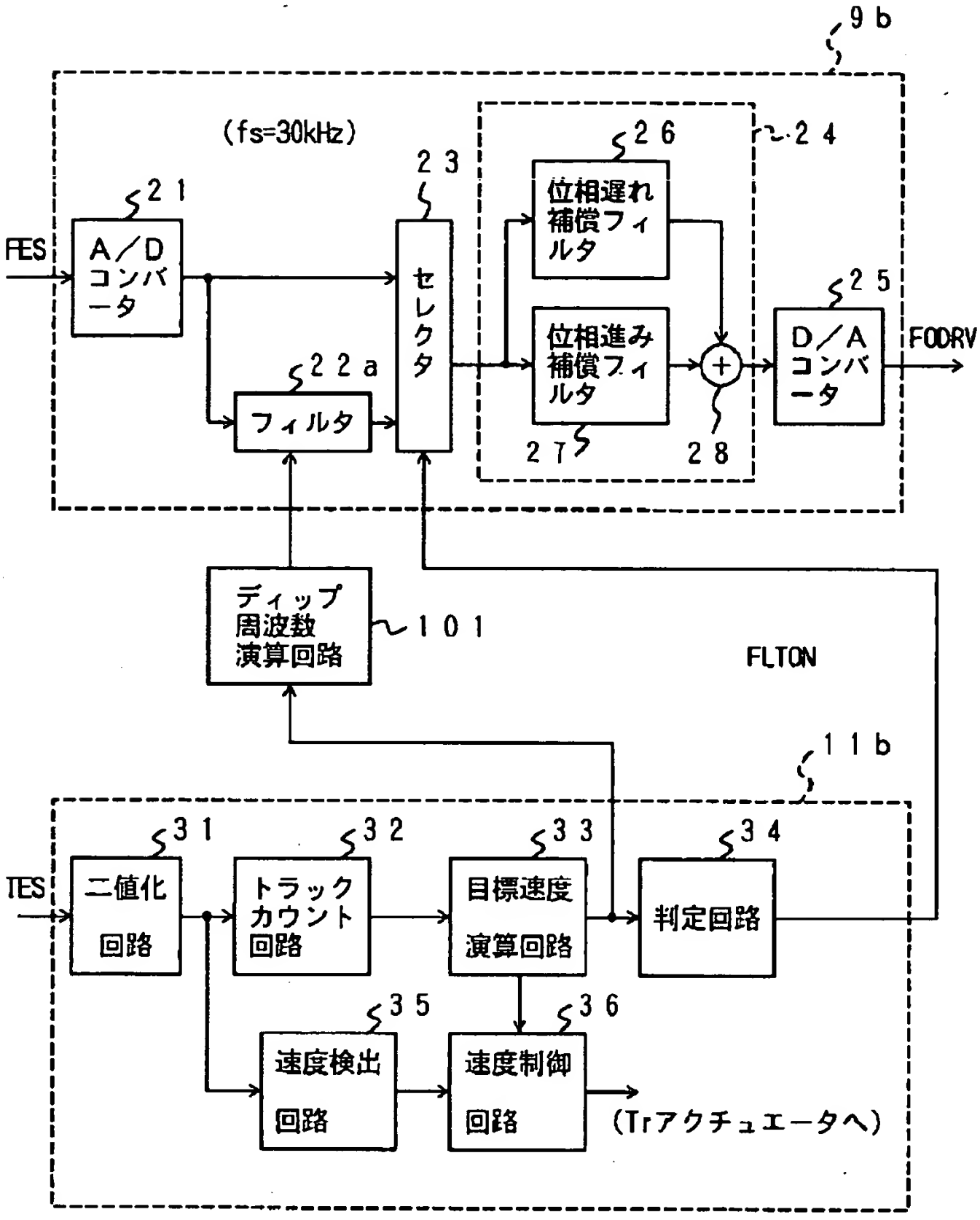
[Drawing 8]



[Drawing 9]



[Drawing 10]



[Translation done.]